This meeting

- **The FNAL PDS (Simulation) group**
  - ➢ Who we are
  - ➢ Communication with IF community
  - ➢ Current activities

- **Simulation interests, needs, issues in IF experiments** – Experiment representatives

- **Discussion**
  - ➢ PDS support of IF experiments
  - ➢ Future projects, collaboration model
  - ➢ Priorities

V. Daniel Elvira

Physics & Detector Simulation in IF Experiments

... and how the FNAL simulation group collaborates with the IF community

V. Daniel Elvira for the PDS group

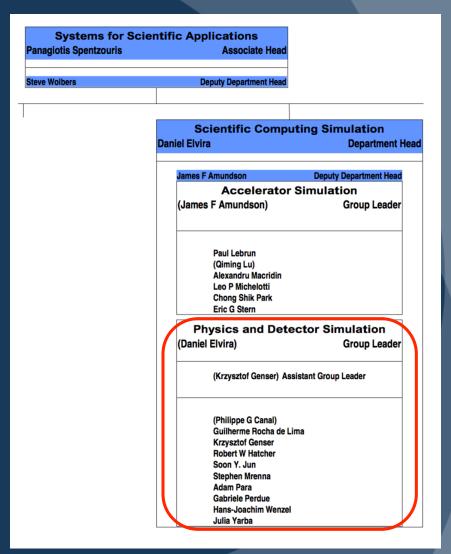Fermi National Accelerator Laboratory

V. Daniel Elvira

The PDS Group

We are part of the Fermilab
Scientific Computing Division

Pythia, GENIE, Geant4
development and support

1. Feature additions and improvements

2. Contributions to experiment specific applications

3. Consultancy

We do not take responsibility for the whole simulation effort in your experiment

Systems for Scientific Applications
Panagiotis Spentzouris — Associate Head

Steve Wolbers — Deputy Department Head

Scientific Computing Simulation
Daniel Elvira — Department Head

James F Amundson — Deputy Department Head

Accelerator Simulation
(James F Amundson) — Group Leader

Paul Lebrun
(Qiming Lu)
Alexandru Macridin
Leo P Michelotti
Chong Shik Park
Eric G Stern

Physics and Detector Simulation
(Daniel Elvira) — Group Leader

(Krzysztof Genser) Assistant Group Leader

(Philippe G Canal)
Guilherme Rocha de Lima
Krzysztof Genser
Robert W Hatcher
Soon Y. Jun
Stephen Mrenna
Adam Para
Gabriele Perdue
Hans-Joachim Wenzel
Julia Yarba

The PDS Group

- **Geant4 and Geant R&D Team**

  ➢ Philippe Canal, Daniel Elvira, Paul Lebrun, Guilherme Lima, Krzysztof Genser, Soon Yung Jun, Hans Wenzel, Julia Yarba

- **GENIE Team**– Gabriel Perdue, Robert Hatcher, Julia Yarba

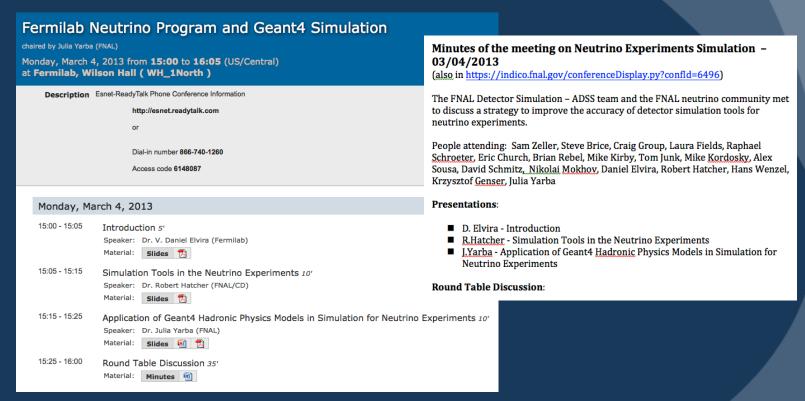- **Pythia Team**– Steve Mrenna (one of three authors)

> PDS is 100% focused on supporting Intensity Frontier experiments

PDS can introduce/represent you at G4 technical (users) forum meetings, communicate more directly with G4 developers within the G4 organization, develop IF features within the G4 working group structures

Communication

Two meetings with the neutrino community, April 23rd 2012, March 4th 2013, helped to design the current PDS group work plan

Fermilab Neutrino Program and Geant4 Simulation

chaired by Julia Yarba (FNAL)

Monday, March 4, 2013 from **15:00** to **16:05** (US/Central)
at **Fermilab, Wilson Hall (WH_1North)**

Description Esnet-ReadyTalk Phone Conference Information

http://esnet.readytalk.com

or

Dial-in number **866-740-1260**

Access code **6148087**

Monday, March 4, 2013

15:00 - 15:05	Introduction *5'* Speaker: Dr. V. Daniel Elvira (Fermilab) Material: Slides
15:05 - 15:15	Simulation Tools in the Neutrino Experiments *10'* Speaker: Dr. Robert Hatcher (FNAL/CD) Material: Slides
15:15 - 15:25	Application of Geant4 Hadronic Physics Models in Simulation for Neutrino Experiments *10'* Speaker: Dr. Julia Yarba (FNAL) Material: Slides
15:25 - 16:00	Round Table Discussion *35'* Material: Minutes

Minutes of the meeting on Neutrino Experiments Simulation – 03/04/2013
(also in https://indico.fnal.gov/conferenceDisplay.py?confId=6496)

The FNAL Detector Simulation – ADSS team and the FNAL neutrino community met to discuss a strategy to improve the accuracy of detector simulation tools for neutrino experiments.

People attending: Sam Zeller, Steve Brice, Craig Group, Laura Fields, Raphael Schroeter, Eric Church, Brian Rebel, Mike Kirby, Tom Junk, Mike Kordosky, Alex Sousa, David Schmitz, Nikolai Mokhov, Daniel Elvira, Robert Hatcher, Hans Wenzel, Krzysztof Genser, Julia Yarba

Presentations:

- D. Elvira - Introduction
- R.Hatcher - Simulation Tools in the Neutrino Experiments
- J.Yarba - Application of Geant4 Hadronic Physics Models in Simulation for Neutrino Experiments

Round Table Discussion:

https://indico.fnal.gov/conferenceDisplay.py?confId=6496

Generators: GENIE

- FNAL is building a GENIE team (R. Hatcher, G. Perdue, J. Yarba)
- The FNAL team is working on implementation of physics models, flux and geometry drivers, and validation infrastructure
  - Implementation of Berger-Sehgal Coherent Pion Model.
  - Formalize and automate validation infrastructure
  - Improvements and maintenance of GENIE flux drivers

- This work, in collaboration with the experiments, will hopefully reduce the turnaround time to incorporate and validate new physics

Week-long "Developers Working Meeting" held at Fermilab on March 10-14, 2014

Detector Simulation: Neutrinos

- Creation of modular *art* based Geant4 framework artg4tk. https://cdcvs.fnal.gov/redmine/projects/artg4tk (by H. Wenzel, based on A. Lyon's g-2 interface and H. Wenzel's CaTS framework)

  ➢ *art*/G4 interface for use by the IF experiments

  ➢ Test bench for validation of G4 physics models relevant to neutrino flux (beam on target), and detector response

- Development of customized "G4 Physics Lists" for neutrino experiments (R. Hatcher, H. Wenzel, J. Yarba)

  ➢ Flux modeling (beam-target interactions)

  ➢ Detector simulation (neutrino induced showers)

First version of a "NuBeam" physics list (J. Yarba) made available to NuMI-X for testing

Detector Simulation: Neutrinos

Ground work toward neutrino specific G4 physics lists

- Validation of G4 hadronic physics models relevant to beam or detector simulation (J. Yarba)
    - ➢ Low-to-intermediate energy (subset of HARP data)
    - ➢ High energy range (NA49, NA61 data)
- Development of Geant4 Validation repository and Web Application to store and display G4 results and data for comparison (H. Wenzel, J. Yarba) http://g4validation.fnal.gov:8080/G4ValidationWebApp/
- G4 physics validation and improvement for LiAr (and noble gases) using LArIAT data (G. Perdue, H. Wenzel)

Simulation Infrastructure & Studies: Neutrinos

Direct contributions to neutrino experiments

- Fixing/Validating FLUGG simulation for NuMI-X (R. Hatcher)

- Packaging of "NuBeam" physics list for use by NuMI-X, LBNE beam simulation (R. Hatcher)

- Tool to overlap MINERvA MC with MINOS data (R. Hatcher)

- Flux file handling in GRID environments (R. Hatcher)

- LBNE simulations to determine alignment tolerances consistent with physics goals (P. Lebrun)

Detector Simulation: Mu2e
(K. Genser)

- Implemented many elements of the detector geometry

- Develop data structures/products and algorithms

- Maintain Geant4 Mu2e Offline framework interface, enabled migration to new G4 versions, performed regression tests

- Created custom G4 physics list for particle production in specific kinematic regions (pion production in the backwards hemisphere), accuracy of (electromagnetic) calculations or presence of specific physics processes

Detector Simulation: Mu2e

(K. Genser)

- Corrected and re-implemented bound muon capture and decay rate functions in Geant4

- Created custom Geant4 version(s) with added labeling of muon capture products and a couple of back-ported critical features

- Implemented a simple histogram comparison tool

- Developed (Mu2e Offline framework based) Geant4 Study Package to perform simple physics and detector studies

Summary & Future

- PDS is involved in GENIE, Pythia, Geant4 development and R&D for Geant to run on future computing platforms

- PDS leads Computing Performance in G4 (CPU/MEM) – Soon Jun

- PDS activities are entirely focused on the FNAL IF program

- We continuously receive and answer questions from neutrino experiments, Mu2e, g-2, …

- Current plan based on dedicated meetings with neutrino experiments and private communication with others (i.e. g-2)

- Adjustments, new directions to be discussed today

How frequently should we call this meeting ?

What should the format be ?